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PERFORMANCE ANALYSIS OF DIFFERENT MATERIAL HANDLING DEVICES IN FLEXIBLE MANUFACTURING SYSTEM

B. SATISH KUMAR[1], G. JANARDHANA RAJU[2] & G. RANGAJANARDHANA[3]

[1]*Associate Professor, Department of Mechanical Engineering, S R Engineering College, Warangal, Telangana, India*

[2]*Dean School of Engineering, Nalla Narsimha Reddy Group of Institutions, Hyderabad, Telangana, India*

[3]*Professor, Department of Mechanical Engineering, University College of Engineering, JNTU Anathapur, Andhra Pradesh, India*

ABSTRACT

A Flexible manufacturing system (FMS) is the group of machines that are most preferably CNC, which will coordinate by a common control center capable of dealing with a variety of the products. It is a manufacturing system, which possesses the flexibility of adopting their machines and factory layouts that are according to the product to be produced. In this paper, performance of AGV, CART for different Layouts like Line Layout, U Layout with different speeds are studied by using flexsim software and suggested different material handling devices for different processes for different layouts.

KEYWORDS: Flexible Manufacturing System, Automated Guided Vehicle & CART's

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Original Article

INTRODUCTION

Manufacturing trades operate in a progressively competitive environment. The profit margin of manufacturing industry, a vital component of economies of nations, has been significantly reduced by globalization. Therefore, productivity of manufacturing system & its ability to respond to the dynamically changing market demands, has become a key focus for both researchers and practitioners. Conventional job shops designed are to manufacture small batches of variety of products. This flexibility is usually off-set by low utilization of the production facilities, long lead times and high in process inventories on the other hand, fixed sequence transfer lines are typically designed at large volume production, high machine utilization and short lead time. Enhancing the productivity of job shop without sacrificing its flexibility had been a long awaited dream of manufacturing system managers. Emergence of flexible manufacturing system (FMS) is an important development in this direction using the novel concept of flexible automation. Lean manufacturing, with focus on the continuous improvement of time, quality, cost, and flexibility has been one of the most successful philosophies and methodologies recently and still huge potential of future deployment remains. Flexible Manufacturing System (FMS) is one of the practical implementations of Lean philosophy. By dynamically respond to system status, FMS is able to significantly reduce the percentage of idle capacity, improve the productivity, and quickly adjust ongoing production based on continuous changing market condition. To achieve the flexibilities included in FMS, machine, process, routing, production, volume, layout, production flexibilities and operation.

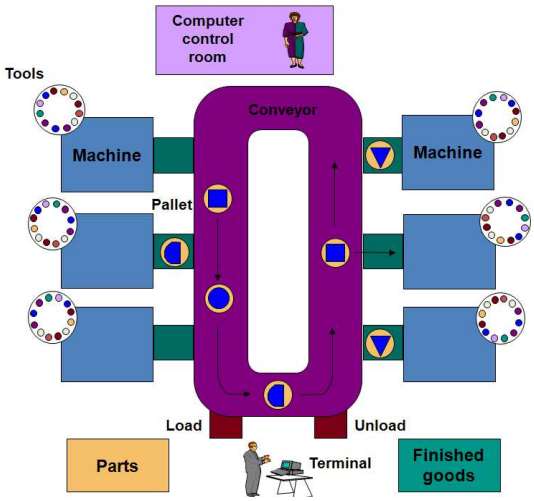

Figure 1

Typical view of FMS

In this paper, an attempt is made to find effective utilization of the material handling devices in the different production layout at different speeds.

LITERATURE SURVEY

A Flexible Manufacturing System is the integrated computer controlled complex of an automated material handling devices & numerically controlled machine tools that can simultaneously enable the process medium sized volumes of a variety of part types [1,8].

Job Shop Scheduling can be easily exercised with the help of simulation based techniques, in which setup times are sequence dependent [2]. The performance of a simulation engine is very important issue in developing optimized simulation based scheduling system, it is necessary to simulate multiple alternatives until given criteria are satisfied[3]. The Simulation results indicate that for infinite buffer capacity, the alternative routings planned combined with the shortest total processing time dispatching rule, gives the best results for all performance measures[4]. The Threshold value for each manufacturing system is unique and has a methodology for determining its unique values. The threshold concept and the performance of threshold based alternate routing will minimize mean flow time [5, 11].

Operational measures help manufacturing managers to make understand the kind and extent of the flexibility embedded in their production process, and one that allows them to make informal judgment's on new equipments [7]. Flexible Manufacturing System is characterized by versatile work stations with minimum changeover times and a versatile material handling system [9,10]. Integrated Methodology based process selection system and flexible manufacturing system's controls simulation model performance in terms of the system status and part routings [13]. Since the problems that arise from resource conflicts, undefined environment events and final product anomalies typically involve rescheduling, there is a necessity to deal with scheduling, material and capacity planning in an integrated way. This paper successfully demonstrates an integration of scheduling with Material Requirement Planning (MRP) and Capacity Requirements Planning [14]. Suitable bacterial handing system is proposed for a layout at different speeds of material handling system [15]. Localized Route Recovery (L2R) protocol is initiated to generate an alternate path for link failures in backbone networks. To ensure link failure recovery, L2R is implemented, the upstream node initiates local route discovery

to generate an alternate path to the destination [16].

In order to overcome the limitations of existing protocols, an Efficient Backbone Based Quick Link Failure Recovery Multicast Routing Protocol is proposed. It is a four phase protocol: Group Formation, Backbone Construction, On-demand Route Discovery and Route Maintenance[17].

CASE STUDY

This study is being carried out on the utilization of resources like processors, material handling devices like AGVs and CARTs that can be better visualized by the use of simulation software. In order to conduct the study within the working environment, some of the conditions to be taken into consideration, such assumed processes for producing parts are tabulated below.

Table 1

Part #	Attributes	Process 1	Process 2	Process 3	Process 4	Process 5
Part 1	Sequence	G3	G4	G1	G5	-
	Processing time	35	30	15	30	-
Part 2	Sequence	G2	G3	G4	G5	-
	Processing time	35	27	31	32	-
Part 3	Sequence	G2	G3	G4	G1	G5
	Processing time	35	27	31	15	32
Part 4	Sequence	G3	G2	G4	G1	G5
	Processing time	27	29	19	15	24
Part 5	Sequence	G3	G1	G4	G5	-
	Processing time	23	17	19	24	-

EXPERIMENTAL DESIGN

The input Factors considered for this analysis are two types of material handling devises i.e. AGV, CART for Layouts Line & U types for manufacturing 5 different parts.

AGV Factors

Table 2

Part #	Layout	No. AGVs	Speed (m/s)	Layout	No. AGVs	Speed (m/s)	Layout	No. AGVs	Speed (m/s)
1	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
2	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
3	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
4	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
5	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
1	U Layout	1	2	U Layout	3	2	U Layout	5	2
2	U Layout	1	2	U Layout	3	2	U Layout	5	2
3	U Layout	1	2	U Layout	3	2	U Layout	5	2
4	U Layout	1	2	U Layout	3	2	U Layout	5	2
5	U Layout	1	2	U Layout	3	2	U Layout	5	2

The above condition are repeated for same layouts and same number of AGVs with varying Speeds 4m/s, 6m/s, 8m/s and 10m/s

CART Factors

Table 3

Part #	Layout	No. Carts	Speed (m/s)	Layout	No. Carts	Speed (m/s)	Layout	No. Carts	Speed (m/s)
1	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
2	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
3	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
4	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
5	Line Layout	1	2	Line Layout	3	2	Line Layout	5	2
1	U Layout	1	2	U Layout	3	2	U Layout	5	2
2	U Layout	1	2	U Layout	3	2	U Layout	5	2
3	U Layout	1	2	U Layout	3	2	U Layout	5	2
4	U Layout	1	2	U Layout	3	2	U Layout	5	2
5	U Layout	1	2	U Layout	3	2	U Layout	5	2

The above condition are repeated for same layouts and same number of AGVs with varying Speeds 4m/s, 6m/s, 8m/s and 10m/s.

METHODOLOGY

In Production Layout, Material Handling Devices are the important factors to reduce the manufacturing lead time. It is impossible to identify the best suited layout when Material Handling devices are practically applied in the layout. This can be easily done with the help of simulation with realistic conditions within the boundaries. Simulation is the realistic prior approach to production process with the conditions, which are exactly similar to the production layout. In this Paper, Simulation type used is FlexSim 7.5.2. This Simulation Software is helpful to identify the behavior of the AGV and CART in the two production Layouts i.e. Line Layout & U Layout. Two material handling devices considered are, Automated Guided Vehicle (AGV) and CART. In each material handling device 5 different speeds are selected naming 2m/s, 4m/s, 6m/s, 8m/s, 10m/s with respect to each layout and with respect to each material handling device. Total production time observed is 10000 Seconds.

Procedure

Step 1: Selecting the Flexsim Software Icon on the desktop, then a window will be displayed as shown in Figure-2

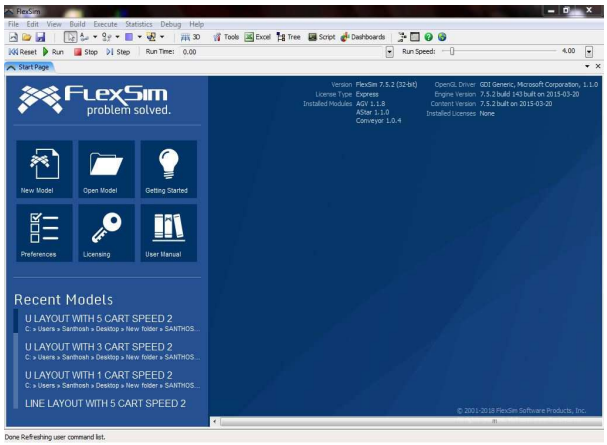

Figure 2

Step 2: Selecting the new model another window is displayed with a layout model shown in Figure-3.

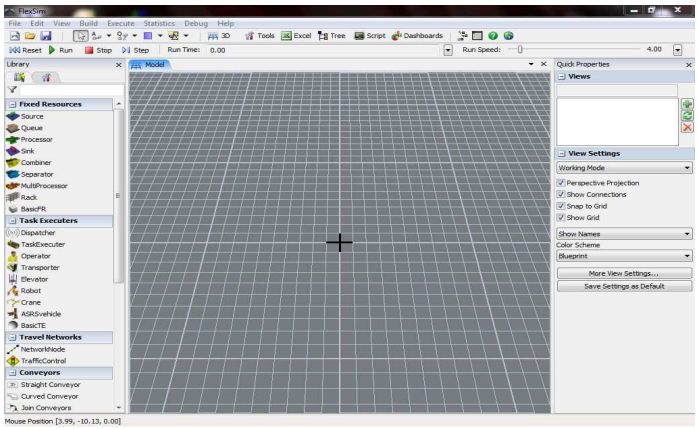

Figure 3

Step 3: In this Layout selecting, the necessary elements are like Source, Sink, Processors, AGV, CART, and Dispatcher.

Step 4: Arranging all the elements in the sequence for the layouts Line and U Layouts.

Step 5: Considering Line Layout.

Step 6: Selecting the Part type Part # 1. In this part, the processes required are G3 (35 Sec), G4 (30 Sec), G1 (15 Sec), G5 (30 Sec).

Step 7: Selecting the processors and selecting the material handling device, say AGV in 1 no.

Step 8: By selecting the properties of the processor, processing time can be changed.

Step 9: Also, selecting the properties of the AGV, we can make the changes in the speed of the vehicle.

Step 10: Making the connections between the processors in the order of G3-G4-G1-G5

Step 11: Connecting the AGV to the processors then layout appear as shown in Figure-4

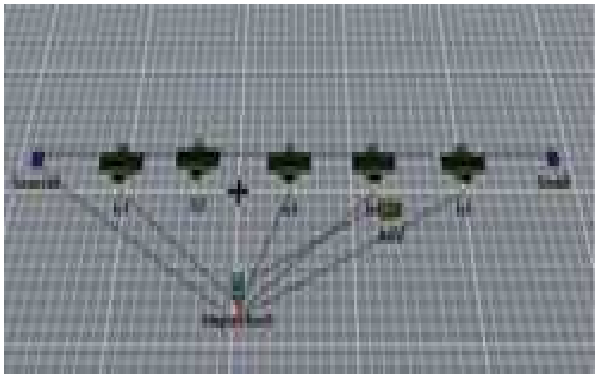

Figure 4: Line Layout with 1 AGV

Step 12: Then, select the run time as 10000 Seconds. Click on Run to make processors work.

Step 13: Then, select the Dashboard from the File Menu bar to get utilization of the processors, AGV.

Step 14: Observe the values and tabulate in table.

Step 15: Repeat the Step 7, Step 8, Step 9, Step 10, Step 11with AGVs in 3 Numbers, then layout appears as shown in Figure-5

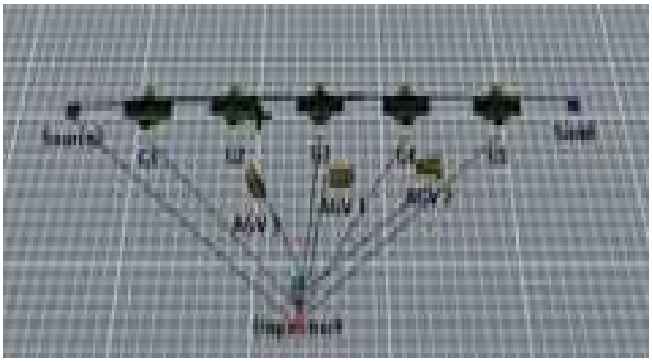

Figure 5: Line Layout with 3 AGV

Step 16: Repeat Step12, Step 13 for the layout.

Step 17: Tabulate the Values from the Dashboard

Step 18: Repeat the Step 7, Step 8, Step 9, Step 10, Step 11with AGVs in 5 Numbers as shown in Figure-6

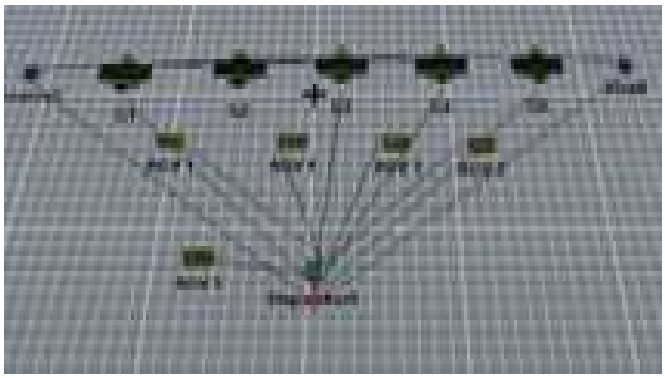

Figure 6: Line Layout with 5 AGV

By reapeting the same frocess for U Layout with different nuber of AGV's, out put vales are tabulated and layouts appears as shown below:

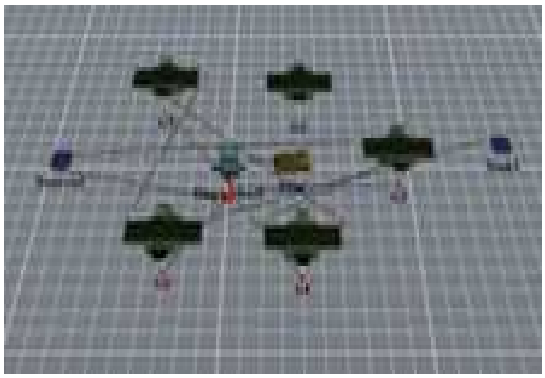

Figure 7: U Layout with 1 AGV

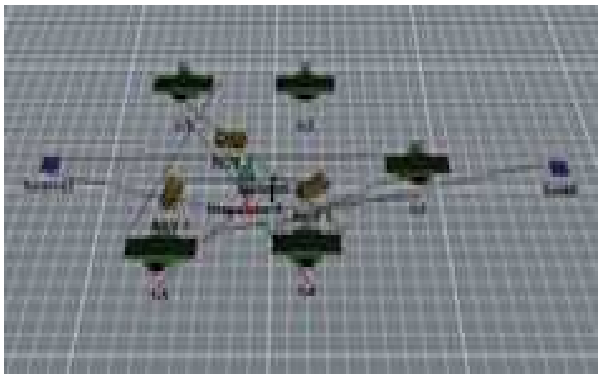

Figure 8: U Layout with 3 AGV

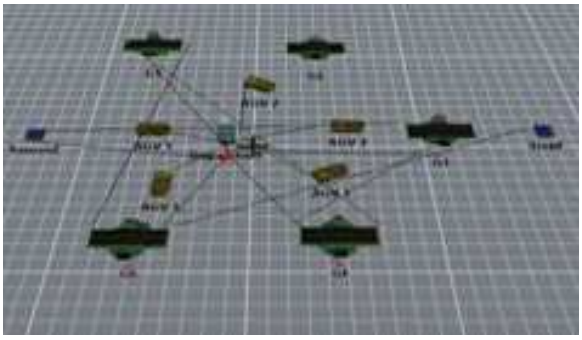

Figure 9: U Layout with 5 AGV

Now, apply the same Layout conditions and replace the AGV with the CART. Results are tabulated and layouts appear are shown below:

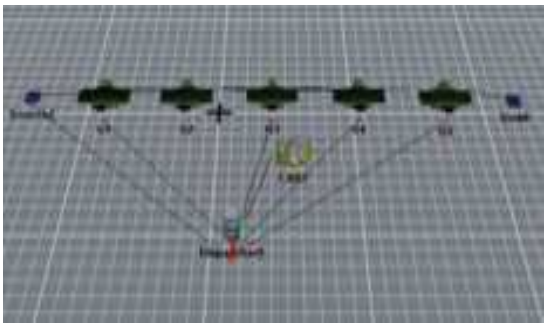

Figure 10: Line Layout with 1 CART

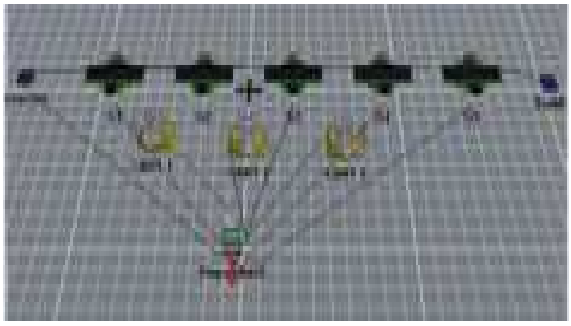

Figure 11: Line Layout with 3 CART

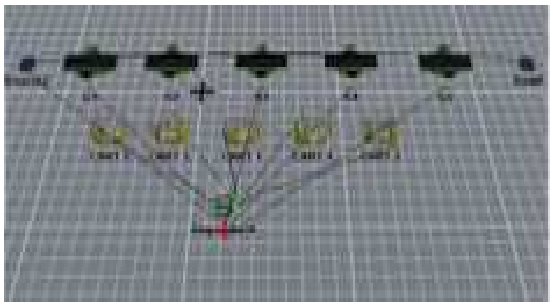

Figure 12: Line Layout with 5 CART

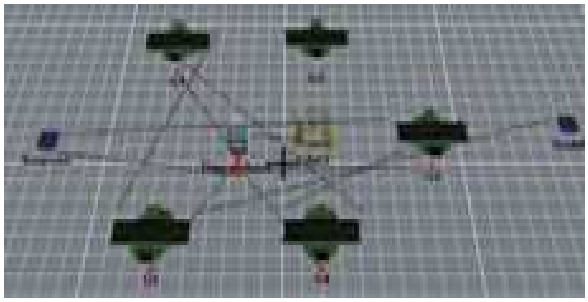

Figure 13: U Layout with 1 CART

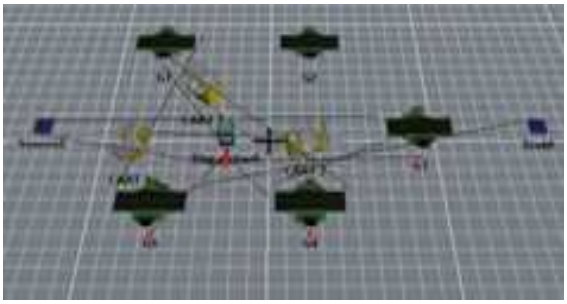

Figure 14: U Layout with 3 CART

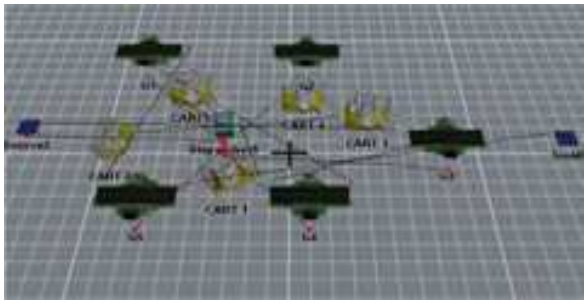

Figure 15: U Layout with 5 CART

Followed the same procedure for the layout Line and U type with AGV and CART with the speeds2 m/s, 4m/s, 6m/s, 8m/s and 10 m/s. Noted down the values from each dashboard and form them in the Tabular Format, with respect to their layouts. Repeated same procedure for the remaining Parts Part#2, Part#3, Part#4, and Part #5 and tabulated the results

RESULTS

Several observations have been made on both AGV's and CART's; Study includes effective results, few of them are as follows:

Table 4

Part #	Attributes	Process 1	Process 2	Process 3	Process 4	Process 5
Part 1	Sequence	G3	G4	G1	G5	-
	Processing time	35	30	15	30	-

Table 5

Object	Class	Idle	Processing	Blocked	Waiting for Transporter	Offset Travel Empty	Offset Travel Loaded
Flexsim Report- LINE LAYOUT WITH 1 AGV SPEED 2m/s, Time-1000 Sec							
Source2	Source	0.00%	0.00%	49.44%	42.85%	0.00%	0.00%
G1	Processor	58.28%	12.45%	1.80%	27.47%	0.00%	0.00%
G2	Processor						
G3	Processor	53.48%	29.41%	0.00%	17.11%	0.00%	0.00%
G4	Processor	43.94%	24.98%	0.00%	31.08%	0.00%	0.00%
G5	Processor	41.71%	24.60%	0.00%	33.69%	0.00%	0.00%
AGV	Task Executer	0.61%	0.00%	0.00%	0.00%	57.48%	41.91%
Flexsim Report- LINE LAYOUT WITH 3 AGV SPEED 2m/s, Time-1000 Sec							
Source2	Source	0.00%	0.00%	63.41%	22.48%	0.00%	0.00%
G1	Processor	59.45%	21.01%	2.39%	17.15%	0.00%	0.00%
G2	Processor						
G3	Processor	38.77%	49.35%	0.00%	11.87%	0.00%	0.00%
G4	Processor	51.46%	42.14%	0.00%	6.40%	0.00%	0.00%
G5	Processor	44.64%	41.76%	0.00%	13.60%	0.00%	0.00%
AGV 2	TaskExecuter	57.45%	0.00%	0.00%	0.00%	22.17%	20.38%
AGV 1	Task Executer	36.36%	0.00%	0.00%	0.00%	33.91%	29.73%
AGV 3	Task Executer	70.21%	0.00%	0.00%	0.00%	14.91%	14.88%
Flexsim Report- LINE LAYOUT WITH 5 AGV SPEED 2m/s, Time-1000 Sec							
Source2	Source	0.00%	0.00%	71.18%	15.79%	0.00%	0.00%
G1	Processor	30.47%	19.81%	30.71%	19.01%	0.00%	0.00%
G2	**Processor**						
G3	Processor	33.28%	46.57%	13.50%	6.64%	0.00%	0.00%
G4	Processor	16.41%	39.71%	33.46%	10.43%	0.00%	0.00%
G5	Processor	40.99%	39.11%	0.00%	19.90%	0.00%	0.00%
AGV 1	TaskExecuter	42.45%	0.00%	0.00%	0.00%	31.26%	26.30%
AGV 2	TaskExecuter	56.47%	0.00%	0.00%	0.00%	21.67%	21.87%
AGV 3	TaskExecuter	88.51%	0.00%	0.00%	0.00%	5.76%	5.73%
AGV 4	TaskExecuter	73.78%	0.00%	0.00%	0.00%	13.11%	13.11%
AGV 5	TaskExecuter	100%	0.00%	0.00%	0.00%	0.00%	0.00%
Flexsim Report- U LAYOUT WITH 1 AGV SPEED 2m/s, Time-1000 Sec							
Source2	Source	0.00%	0.00%	50.46%	38.86%	0.00%	0.00%
G1	Processor	24.40%	16.52%	12.54%	46.54%	0.00%	0.00%
G2	Processor						
G3	Processor	50.83%	38.88%	0.00%	10.28%	0.00%	0.00%
G4	Processor	33.55%	33.01%	19.77%	13.67%	0.00%	0.00%
G5	Processor	54.97%	32.73%	0.00%	12.30%	0.00%	0.00%
AGV	TaskExecuter	7.87%	0.00%	0.00%	0.00%	46.89%	45.24%

Table 6

Object	Class	Idle	Processing	Blocked	Waiting for Transporter	Offset Travel Empty	Offset Travel Loaded
Flexsim Report- U LAYOUT WITH 3 AGV SPEED 2m/s, Time-1000 Sec							
Source2	Source	0.00%	0.00%	68.12%	17.57%	0.00%	0.00%
G1	Processor	62.29%	21.32%	0.00%	16.39%	0.00%	0.00%
G2	Processor						
G3	Processor	35.45%	50.12%	0.00%	14.43%	0.00%	0.00%
G4	Processor	53.09%	42.63%	0.00%	4.28%	0.00%	0.00%
G5	Processor	50.03%	42.31%	0.00%	7.65%	0.00%	0.00%
AGV 1	TaskExecuter	43.91%	0.00%	0.00%	0.00%	25.71%	30.38%
AGV 2	TaskExecuter	56.41%	0.00%	0.00%	0.00%	21.51%	22.08%
AGV 3	TaskExecuter	71.84%	0.00%	0.00%	0.00%	13.07%	15.09%
Flexsim Report- U LAYOUT WITH 5 AGV SPEED 2m/s, Time-1000 Sec							
Source2	Source	0.00%	0.00%	70.89%	14.95%	0.00%	0.00%
G1	Processor	62.02%	20.87%	0.00%	17.11%	0.00%	0.00%
G2	Processor						
G3	Processor	33.78%	49.37%	0.00%	16.85%	0.00%	0.00%
G4	Processor	50.26%	42.08%	0.00%	7.65%	0.00%	0.00%
G5	Processor	45.92%	41.74%	0.00%	12.34%	0.00%	0.00%
AGV 1	TaskExecuter	54.32%	0.00%	0.00%	0.00%	23.42%	22.27%
AGV 2	TaskExecuter	44.54%	0.00%	0.00%	0.00%	23.68%	31.79%
AGV 3	TaskExecuter	70.63%	0.00%	0.00%	0.00%	12.92%	16.45%
AGV 4	TaskExecuter	82.05%	0.00%	0.00%	0.00%	8.93%	9.02%
AGV 5	TaskExecuter	100%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 7

Object	Class	Idle	Processing	Blocked	Waiting for Transporter	Offset Travel Empty	Offset Travel Loaded	Travel Empty	Travel Loaded
Flexsim Report- LINE LAYOUT WITH 1 CART SPEED 2m/s, Time-1000 Sec									
Source2	Source	0.00%	0.00%	70.28%	16.75%	0.00%	0.00%	0.00%	0.00%
G1	Processor	61.60%	19.6%	0.00%	18.75%	0.00%	0.00%	0.00%	0.00%
G2	Processor								
G3	Processor	27.77%	46.2%	0.00%	25.97%	0.00%	0.00%	0.00%	0.00%
G4	Processor	60.39%	39.6%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
G5	Processor	47.52%	39.3%	0.00%	13.15%	0.00%	0.00%	0.00%	0.00%
CART	Trasporter	15.75%	0.0%	0.00%	0.00%	5.08%	1.63%	48.5%	28.9%
Flexsim Report- LINE LAYOUT WITH 3 CART SPEED 2m/s, Time-1000 Sec									
Source2	Source	0.00%	0.00%	67.30%	14.88%	0.00%	0.00%	0.00%	0.00%
G1	Processor	56.29%	25.66%	3.47%	14.58%	0.00%	0.00%	0.00%	0.00%
G2	Processor								
G3	Processor	29.19%	60.39%	0.00%	10.42%	0.00%	0.00%	0.00%	0.00%
G4	Processor	43.10%	51.67%	0.00%	5.23%	0.00%	0.00%	0.00%	0.00%
G5	Processor	34.47%	51.12%	0.00%	14.41%	0.00%	0.00%	0.00%	0.00%
CART 1	Transporter	47.25%	0.00%	0.00%	0.00%	5.68%	1.21%	19.7%	26.1%
CART 2	Transporter	66.31%	0.00%	0.00%	0.00%	3.00%	0.67%	15.7%	14.2%
CART 3	Transporter	71.32%	0.00%	0.00%	0.00%	1.28%	0.43%	13.3%	13.6%
Flexsim Report- LINE LAYOUT WITH 5 CART SPEED 2m/s, Time-1000 Sec									
Source2	Source	0.00%	0.00%	62.82%	20.43%	0.00%	0.00%	0.00%	0.00%
G1	Processor	56.10%	24.01%	5.94%	13.96%	0.00%	0.00%	0.00%	0.00%
G2	Processor								
G3	Processor	33.20%	56.38%	0.00%	10.42%	0.00%	0.00%	0.00%	0.00%
G4	Processor	46.81%	48.01%	0.00%	5.19%	0.00%	0.00%	0.00%	0.00%
G5	Processor	39.37%	47.74%	0.00%	12.89%	0.00%	0.00%	0.00%	0.00%
CART 1	Transporter	44.60%	0.00%	0.00%	0.00%	6.46%	1.10%	19.21%	28.63%
CART 2	Transporter	66.27%	0.00%	0.00%	0.00%	2.74%	0.80%	17.51%	12.67%
CART 3	Transporter	73.92%	0.00%	0.00%	0.00%	1.27%	0.41%	13.35%	11.04%
CART 4	Transporter	95.33%	0.00%	0.00%	0.00%	0.14%	0.06%	2.22%	2.24%
CART 5	Transporter	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 8

Object	Class	Idle	Processing	Blocked	Waiting for Transporter	Offset Travel Empty	Offset Travel Loaded	Travel empty	Travel loaded
Flexsim Report- U LAYOUT WITH 1 CART SPEED 2m/s, Time-1000 Sec									
Source2	Source	0.00%	0.00%	50.20%	39.01%	0.00%	0.00%	0.00%	0.00%
G1	Processor	22.05%	16.83%	14.67%	46.44%	0.00%	0.00%	0.00%	0.00%
G2	Processor								
G3	Processor	50.28%	39.67%	0.00%	10.05%	0.00%	0.00%	0.00%	0.00%
G4	Processor	34.72%	33.69%	19.03%	12.57%	0.00%	0.00%	0.00%	0.00%
G5	Processor	53.90%	33.37%	0.00%	12.73%	0.00%	0.00%	0.00%	0.00%
CART	Transporter	12.12%	0.00%	0.00%	0.00%	7.16%	1.67%	39.23%	39.82%
Flexsim Report- U LAYOUT WITH 3 CART SPEED 2m/s, Time-1000 Sec									
Source2	Source	0.00%	0.00%	68.02%	14.70%	0.00%	0.00%	0.00%	0.00%
G1	Processor	64.78%	24.31%	0.00%	10.90%	0.00%	0.00%	0.00%	0.00%
G2	Processor								
G3	Processor	31.98%	57.16%	0.00%	10.86%	0.00%	0.00%	0.00%	0.00%
G4	Processor	44.17%	48.96%	0.00%	6.87%	0.00%	0.00%	0.00%	0.00%
G5	Processor	38.59%	48.61%	0.00%	12.80%	0.00%	0.00%	0.00%	0.00%
CART 1	Transporter	43.62%	0.00%	0.00%	0.00%	6.67%	1.22%	21.35%	27.13%
CART 2	Transporter	55.99%	0.00%	0.00%	0.00%	1.21%	0.95%	17.82%	24.03%
CART 3	Transporter	83.83%	0.00%	0.00%	0.00%	0.58%	0.25%	6.98%	8.36%
Flexsim Report- U LAYOUT WITH 5 CART SPEED 2m/s, Time-1000 Sec									
Source2	Source	0.00%	0.00%	67.88%	16.29%	0.00%	0.00%	0.00%	0.00%
G1	Processor	60.46%	22.69%	0.00%	16.84%	0.00%	0.00%	0.00%	0.00%
G2	Processor								
G3	Processor	32.21%	53.20%	0.00%	14.58%	0.00%	0.00%	0.00%	0.00%
G4	Processor	54.20%	45.38%	0.00%	0.42%	0.00%	0.00%	0.00%	0.00%
G5	Processor	51.12%	45.07%	0.00%	3.82%	0.00%	0.00%	0.00%	0.00%
CART 1	Transporter	67.39%	0.00%	0.00%	0.00%	4.35%	0.77%	10.78%	16.72%
CART 2	Transporter	54.49%	0.00%	0.00%	0.00%	4.20%	1.11%	16.50%	23.70%
CART 3	Transporter	68.26%	0.00%	0.00%	0.00%	1.13%	0.38%	15.00%	15.23%
CART 4	Transporter	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CART5	Transporter	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 9

Object	Class	Idle	Processing	Blocked	Waiting for Transporter	Offset Travel Empty	Offset Travel Loaded	Travel Empty	Travel Loaded
Flexsim Report- U LAYOUT WITH 1 CART SPEED 4m/s, Time-1000 Sec									
Source2	Source	0.00%	0.00%	71.43%	11.94%	0.00%	0.00%	0.00%	0.00%
G1	Processor	63.67%	23.91%	0.00%	12.41%	0.00%	0.00%	0.00%	0.00%
G2	Processor								
G3	Processor	50.28%	39.67%	0.00%	10.05%	0.00%	0.00%	0.00%	0.00%
G4	Processor	34.72%	33.69%	19.03%	12.57%	0.00%	0.00%	0.00%	0.00%
G5	Processor	53.90%	33.37%	0.00%	12.73%	0.00%	0.00%	0.00%	0.00%
CART	Transporter	12.12%	0.00%	0.00%	0.00%	7.16%	1.67%	39.23%	39.82%
Flexsim Report- U LAYOUT WITH 3 CART SPEED 4m/s, Time-1000 Sec									
Source2	Source	0.00%	0.00%	63.69%	16.86%	0.00%	0.00%	0.00%	0.00%
G1	Processor	62.01%	28.96%	0.06%	8.96%	0.00%	0.00%	0.00%	0.00%
G2	Processor								
G3	Processor	26.22%	68.09%	0.00%	5.69%	0.00%	0.00%	0.00%	0.00%
G4	Processor	36.72%	58.25%	0.00%	5.03%	0.00%	0.00%	0.00%	0.00%
G5	Processor	30.67%	57.91%	0.00%	11.42%	0.00%	0.00%	0.00%	0.00%
CART 1	Transporter	42.60%	0.00%	0.00%	0.00%	4.38%	1.85%	28.96%	22.21%
CART 2	Transporter	79.19%	0.00%	0.00%	0.00%	1.10%	0.48%	10.82%	8.41%
CART 3	Transporter	80.93%	0.00%	0.00%	0.00%	1.43%	0.49%	8.64%	8.52%
Flexsim Report- U LAYOUT WITH 5 CART SPEED 4m/s, Time-1000 Sec									
Source2	Source	0.00%	0.00%	67.92%	11.09%	0.00%	0.00%	0.00%	0.00%
G1	Processor	59.70%	30.77%	0.06%	9.46%	0.00%	0.00%	0.00%	0.00%
G2	Processor								

Table 9: Contd.,									
G3	Processor	20.69%	72.16%	0.00%	7.15%	0.00%	0.00%	0.00%	0.00%
G4	Processor	36.04%	61.60%	0.00%	2.37%	0.00%	0.00%	0.00%	0.00%
G5	Processor	34.72%	61.21%	0.00%	4.07%	0.00%	0.00%	0.00%	0.00%
CART 1	Transporter	51.44%	0.00%	0.00%	0.00%	3.08%	1.56%	16.28%	27.63%
CART 2	Transporter	91.51%	0.00%	0.00%	0.00%	0.78%	0.98%	3.57%	3.16%
CART 3	Transporter	80.20%	0.00%	0.00%	0.00%	1.50%	0.52%	8.93%	8.85%
CART 4	Transporter	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CART 5	Transporter	100%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Possible observations have been made on different parts within the production layouts. The results were obtained accurately and concluded as, the CART factors minimize the work flow time etc. comparable with the AGV's.

CONCLUSIONS

Production layout with material handling devices concludes that effective utilization of the processors and material handling devices is useful. When comes to the criteria of effective usage of the AGV and CART is concerned, CART is better choice than AGV in the layout. As the results shows, blocking of the processors is more when AGV is used, than with the usage of CART. Also, helps us to determine the requirement of the AGVs and CARTs for the production layout.

FUTURE SCOPE

Observations can be done on considering setup time, unloading time, processing time individually, and production cost for each product and Labor charges for the production

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